STRUCTURE OF PHYSICAL SPACE
AND NEW INTERACTION IN NATURE
(THEORY AND EXPERIMENTS)

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In the talk, on the basis of the author's model of formation of the observable physical space R_3 in the process of dynamics of special discrete one-dimensional vectorial objects, *byuons*, while minimizing their potential energy of interaction in the one-dimensional space R_1 formed by them, the existence of global anisotropy of observable space and new interaction in nature, is shown. The data of recent experiments are given and discussed.

1. Introduction.

A wealth of works, beginning from antiquity (Aristoteles, Euclides, Democritus) and ending with authors of *XX*-th century, are dedicated to the structure of space and time, to the physical sense of these fundamental concepts, and their properties[1]. In all existing works on quantum field theory and physics of elementary particles, the space in which elementary processes occur, as a rule, is given one way or another. Yet we will follow another way and try to build physical space and major properties of elementary objects in this space from dynamics of a finite set of special discrete objects (so called *byuons*)[2]. Note that the development of physical comprehension of elementary processes on the base of modern superstring models[3], unfortunately, also gives no evidences for how structured is the observed space itself which is obtained, according to one of the models, by means of compactification of six dimensions in a ten-dimensional space. New theoretical approaches found in construction of physical space have given the chance to look in a new way also at the most studied object of the classic and quantum field theory, the electromagnetic field[4]. In the present paper we consider only basic statements of the byuon theory as well as the new interaction connected with the existence of the cosmological vectorial potential,

a new fundamental vectorial constant entering into the definition of byuons. From a wealth of experimental material on investigating the new interaction[5−7], we shall briefly consider only the influence of the new interaction on the rate of the β-decay of radioactive elements[7].

2. Fundamental Theoretical Concepts of Physical Space Origin and of New Force.

In Ref.[2], the conception of formation of the observed physical space R_3 from a finite set of byuons is given. The byuons $\boldsymbol{\Phi}(i)$ are one-dimensional vectors and have the form:

$$\boldsymbol{\Phi}(i) = \mathbf{A_g}x(i),$$

where $x(i)$ is the "length" of the byuon, a real (positive, or negative) value depending on the index $i = 0, 1, 2, ..., k...$, a quantum number of $\boldsymbol{\Phi}(i)$; under $x(i)$ a certain time charge of the byuon may be meant (with $x(i)$ in centimeters). The vector $\mathbf{A}_g$ represents the cosmological vectorial potential, a new basic vectorial constant [2]. It takes only two values:

$$\mathbf{A_g} = \left\{ \begin{array}{c} A_g \\ -\sqrt{-1}A_g \end{array} \right\},$$

where A_g is the modulus of the cosmological vectorial potential ($A_g \approx 1.95 \times 10^{11}$ CGSE units). According to the theory [2], the value A_g is the limiting one. In reality, there exists in nature, in the vicinity of the Earth, a certain summary potential, since the vectorial potential fields from the Sun ($A_\odot \approx 10^8$ CGSE units), the Galaxy ($\sim 10^{11}$ CGSE units), and the Metagalaxy ($> 10^{11}$ CGSE units) are superimposed on the constant A_g resulting probably in some turning of $\mathbf{A}_\Sigma$ relative to the vector $\mathbf{A_g}$ in the space R_3 and in a decrease of it.

Hence in the theory of physical space (vacuum) which the present article leans upon, the field of the vectorial potential introduced even by Maxwell gains a fundamental character. As is known, this field was believed as an abstraction. All the existing theories are usually gauge invariant. For example, in classical and quantum electrodynamics, the vectorial potential is defined with an accuracy of an arbitrary function gradient, and the scalar potential is with that of time derivative of the same function, and one takes only the fields of derivatives of these potentials, i.e. magnetic flux density and electric field strength, as real.

ln Refs.[8−12],local violation of the gauge invariance and Poincaret's group was supposed, and the elementary particle charge and quantum number formation processes were investigated in some set, therefore the potentials gained an unambiguous physical meaning there. In the present paper, this is a finite set of byuons. The works by D.Bohm and Ya.Aharonov discussing the special meaning of potentials in quantum mechanics are the most close to the approach under consideration.

The byuons may be in four vacuum states (VS) II^+, I^+, II^-, I^-, in which they discretely change the value ot $x(i)$: the state II^+ discretely increases ($c = c_0 = \tilde{x}_0/\tau_0$, where $\tilde{x}_0$ - quantum of space ($\approx 10^{-33}$cm), τ_0 - quantum of time ($\approx 10^{-43}c$)) and I^+ decreases $x(i) > 0$ ($c = -c_o = -\tilde{x}_0/\tau_0$); the states II^- and I^- discretely increase or decrease the modulus of $x(i) < 0$, respectively (II^- corresponds to $c = -c_0$, I^- corresponds to $c = c_0$). The sequence of discrete changes of $x(i)$ value is defined as a proper discrete time of the byuon. The byuon vacuum states originate randomly[2].

In Ref.[2], the following hypothesis has been put forward:

It is suggested that the observed space R_3 is built up as a result of minimizing the potential energy of byuon interactions in the one-dimensional space R_1 formed by them. More precisely, the space R_3 is fixed by us as a result of dynamics arisen of byuons. The dynamic processes and, as a consequence, wave properties of elementary particles appear therewith in the space R_3 for objects with residual positive potential energy of byuon interaction (objects observed).

Let us briefly list the results obtained earlier when investigating the present model of physical vacuum.

1. The existence of a new long-range interaction in nature, arising when acting on physical vacuum by the vectorial potential of high-current systems, has been predicted[5].

2. All the existing interactions (strong, weak, electromagnetic and gravitational ones) along with the new interaction predicted have been qualitatively explained in the unified context of changing in three periods of byuon interactions k, N, P with characteristic scales - $x_0 = \tilde{x}_0 k \approx 10^{-17}$cm, $ct^* = \tilde{x}_0 kN \approx 10^{-13}$cm, and $\tilde{x}_0 kNP \approx 10^{28}$cm, determined from the minimum potential energy of byuon interaction[2].

3. Masses of leptons, basic barions and mesons have been found[11,12].

4. The constants of weak interaction (vectorial and axial ones) and of strong interaction have been calculated[11,12].

5. The origin of the galactic and intergalactic magnetic fields has been explained as a result of existence of an insignificant ($\approx 10^{-15}$) asymmetry in the formation process of R_3 from the one-dimensional space of byuons[2].

6. The matter density observed in the Universe ($\approx 10^{-29}g/cm^3$) has been computed[2].

7. The origin of the relic radiation has been explained on the basis of unified mechanism of the space R_3 formation from one-dimensional space R_1 of byuons[2].

8. $\mathbf{A_g}$-vector has coordinates $\alpha \approx 270°, \delta \approx 34°$ in the second equatorial system[5-7].

Let us explain item 1 briefly. It is shown in Ref. [2,12] that masses of all elementary

particles are proportional to the modulus of $\mathbf{A_g}$. If we direct now the vectorial potential of a magnetic system in some space region towards the vector $\mathbf{A_g}$ then any material body will be forced out of the region where $|\mathbf{A_\Sigma}| < |\mathbf{A_g}|$. The new force is nonlocal and nonlinear. This force is directed mainly by the direction of the vector $\mathbf{A_g}$, but as the latest experiments have shown, there is also an isotropic component of the new force.

It can be shown that the magnituge

$$F \sim \Delta A \cdot \frac{\partial \Delta A}{\partial X}.$$

We will take ΔA equal to the difference in $|\mathbf{A_\Sigma}|$ changes due to the source of magnetic field at the location points of a weight (test body) and sensing element; $\frac{\partial \Delta A}{\partial X}$ is gradient of ΔA at R_3.

One of the important predictions of the theory is revealing a new information channel in the Universe which is associated with the existence of a minimum object with positive potential energy, so called object $4b$, arising in the minimum four-contact interaction of byuons in the vacuum states II^+, I^+, II^-, I^-. Object $4b$ may be identified with the pair of the neutrino-antineutrino ($\nu_e \Leftrightarrow \tilde{\nu}_e$) In four-contact byuon interaction, a minimum action equal to h (Planck's constant) occurs, and the spin of the object appears. Hence the greater part of the potential energy of byuon interaction is transformed into the spin of the object $4b$. The residual (after minimization) potential energy of the object $4b$ is equal to $\approx 33eV$. It is identified with the rest mass of this object in the space R_1. In agreement with Refs.[2], the indicated minimum object $4b$ has, according to Heisenberg uncertainty relation, the uncertainty in coordinate $\Delta x \approx 10^{28}$cm in R_3. The total energy of these objects determines near 98% energy of the Universe as well as its matter density observed (dark matter).

3. Experimental Investigatios on Influence of Vectorial Potential of Magnetic Systems on β-decay Count Rate.

It was shown[2,12] that the essence of the weak interactions consists in extending the process of forming the electrical charge of the particle over minimum distance of $\sim 2x_0$, or, in terms of the theory of R_3 space formation from byuons, over two periods of byuon interaction, i.e. over $2x_0 = 2k\tilde{x}_0$. The "extension" is in the direction of the vector $\mathbf{A}_g$. For the model of weak four-fermion interaction with a current taken in the form of the sum of weak vectorial current V' and weak axial (psevdovectorial) current A' ($V' - A'$ - interaction), the interaction constants C_V and C_A have been determined in terms of the new ideology[2,12] as $|C_{V,A}| \sim 1/|\mathbf{A}_g|^2$. Since the energy of decay electrons $E_\beta \sim |A_\Sigma|$, and the probability of β-decay[13] $W \sim |C_{V,A}|^2 E_\beta^5$ in the framework of $V' - A'$ - interaction, we have $W \sim |A_\Sigma|$.

Thus, as $|A_\Sigma|$ changes under the influence of vectorial potential of a magnetic system, one might expect W being also changed.

In the existing pulsed solenoidal systems one can achieve values of the vectorial magnetic potential A_g at a level of about $10^6 - 10^7 Gs \cdot cm$, i.e. the deviation of the decay number N from the initial value of registered decay events N_0 will not exceed $N \sim AN_0/A_g = 10^{-5}N_0$. As is shown above, the vectorial magnetic potentials of the Earth's and Sun's magnetic dipoles can exceed the above mentioned value of A by one-two orders. In this case one may expect deviations of the decay number at a level of 10^{-3} from the undisturbed value, what substantially simplifies the conditions of measurements for detecting the effect.

As the expression for the new force contains not only ΔA but $\frac{\partial \Delta A}{\partial X}$, too, one may assume the variation of probability ΔW of β-decay to be proportional to $\Delta A \cdot \frac{\partial \Delta A}{\partial X}$. As is known[13], the neutron has a magnetic moment $M_n \approx 10^{-23} erg/Gs$. Scale estimations show that in connection with the presence of M_n, we can say about the values of $\frac{\partial \Delta A}{\partial X} \approx 10^{16} Gs \cdot cm$ and $\Delta A \approx 10^3 Gs \cdot cm$ in the vicinity of a neutron. Because of the rotation of the Earth and the action of the Sun's magnetic system, ΔA can vary in time over five orders of magnitude and more. Hence we may assume, that the variation of W due to the action of the new force can be observable.The experiment was principally based on a search for 24-hour's periods of oscillations in intensity of β-decay caused by the action of the vectorial potential $\mathbf{A_E}$, and on the fixation of these periods in spacial coordinates. By now six runs of experiments have been performed to verify this assumption. We shall consider only one run of experiments (August-September, 1996)[7].

Experiment

The experiment was carried out in the Laboratory for nuclear reactions (FLNR) named after G.N.Flerov, at JINR (Dubna)[7]. The measurements were made by the scintillation procedure with a ^{90}Sr-source.

Analysis of Experiments

The results are shown in Figs.1-3. The standard Fourier analysis of the series (Fig.1) was carried out. In Fig.2 where the results are presented, at least two frequencies stand out, of which the former ("great peak") corresponds to approximately half-week period, and the latter ("small peak") does to the daily one. The daily periodicity found by Fourier-method gives, however, no way to determine the astronomical time of an event when the measured value is greater or less than the average. The following procedure was used to refine the distribution of β-decay numbers over the astronomical day. Each moment (minute) of measurement was

represented as a point of a circle (corresponding to an astronomical day) and expressed in degrees, so that the whole series could be "coiled" around that circle. Thus, each measurement was related to a certain time of day (in degrees). If the quantity to be measured is isotropic in time, then the distribution thereof over the circle will be uniform, and the hypothesis for uniformity of said distribution may be verified by statistical methods. For this purpose we used the Kolmogoroff-Smirnoff's test.

According to our conception of influence of changes in A_Σ on the β-decay count rate, we are interested primarily in values of fluxes lesser than the average indication of the instrument. On this basis, when analyzing a distribution, we take into account only the values $L \times S$ lesser than the average where S is the standard deviation of the entire series (Fig.1), and L is a factor determining the extent of deviation from the average. For each of such an extreme value, one notes the point in time at which that takes place, and tests the hypothesis for uniformity of distribution of those points over the astronomical day expressed in degrees (24 hours are equal to $360°$). In Fig.3 the results of computation for $L = 2$ are graphically represented. The X axis is astronomical time in degrees (from $0°$ to $360°$), the Y axis is deviation from the uniform distribution. The confidence interval for $P = 0.05$ is shown dashed. It is clearly seen that the frequency function of the sample is highly nonuniform and peaks at an angle of about $90°$. At this point, the 5% level of significance is far exceeded.

Since the counting in this experiment began on 23rd August, 1996, at 20 hs according to Moscow time (i.e. at 18 hs of astronomical time), the angle of $90°$ corresponds to 24 hs of astronomical time. In Fig.4 the indicated point of time is asterisked. At the starred point (*), a tangent to the line of vectorial potential $\mathbf{A_E}$ of the Earth's magnetic field is drawn (Fig.4). The tangent forms an angle of $\sim 30°$ with the assumed direction of $\mathbf{A_g}$. In the Fig.4 the similar asterisks and tangent lines indicate points of extremum deviations in variations of W for the run of experiments carried out before 1999. The astronomical times of extremums are shown, too. As is seen from the Fig.4, the tangents to the line of the vectorial potential $\mathbf{A_E}$ discern two directions making an angle around $30° - 45°$ with the line of $\mathbf{A_g}$ to the left or right of it. The obtained result corresponds to our theoretical views of the action of the new force.

The experiment in JINR goes on uninterruptedly since 09.12.1998. The results of February and March, 1999, are coincident with those of 1998 with an accuracy of $5 - 10°$. It is interesting also to note that the results of experiments carried out in April, 1998, are coincident with the experiments performed in April, 1994 by another collective of authors[7]. Before long, they will be presented to the journal "Modern Physics" as a collective work.

ACKNOWLEDGEMENTS.

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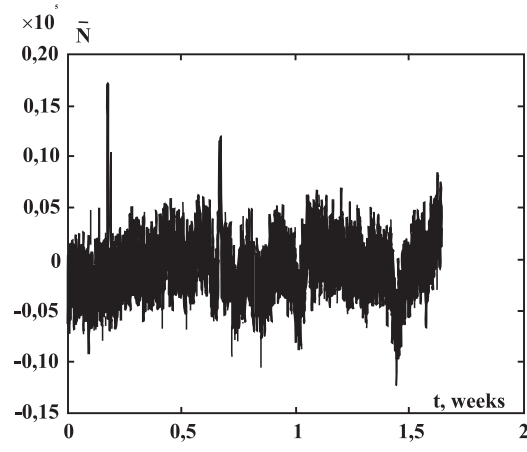
Figure 1: The normalized count rate averaged over 1 minute versus time after extracting of the nonlinear trend from the initial series of measurements.
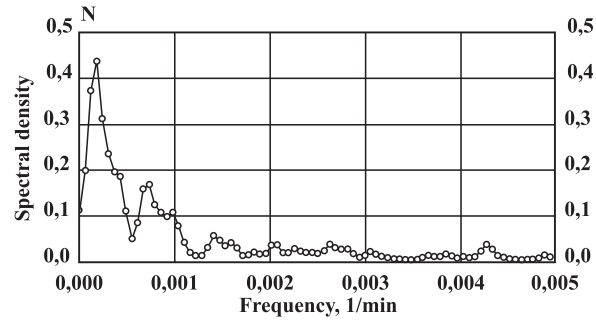

Figure 2: The Fourier spectrum of the signal shown in Fig.3. The first peak corresponds to half-week period, the second one corresponds to 24-hour period.
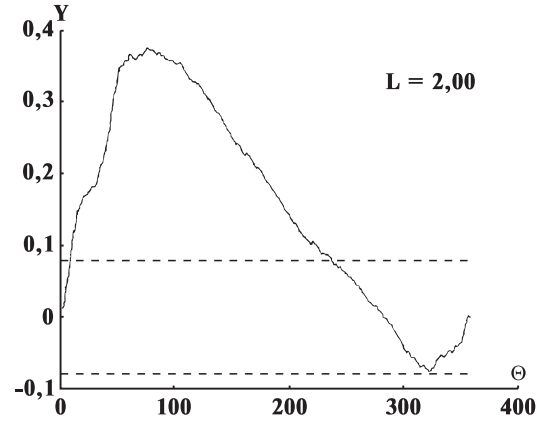
Figure 3:   The dynamics of the ununiformity for a 24-hour period. Y is the Kolmogorov statistic value.
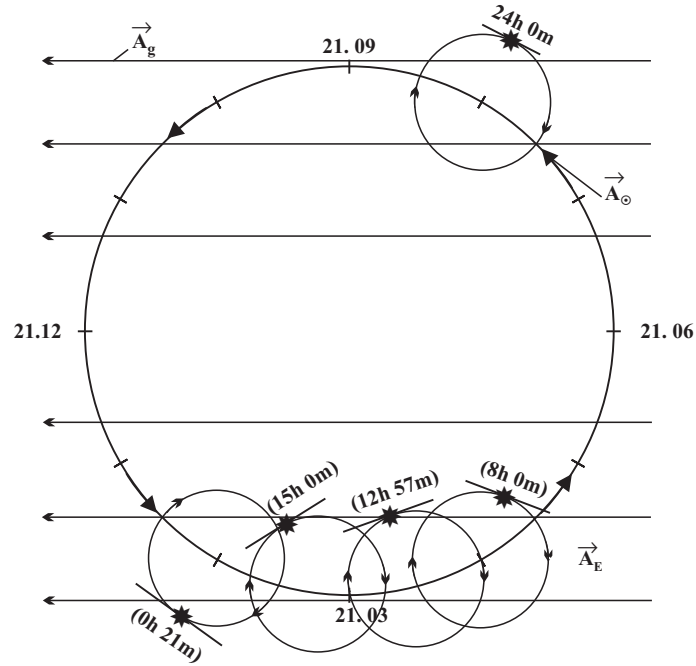

Figure 4: The directions of the $\mathbf{A}_g$ vector and vectorial potentials of magnetic fields from the Sun $\mathbf{A}_\odot$ and the Earth $\mathbf{A}_E$. 8^h, (*) - astronomical time points corresponding to extremum changes in β-decay count rate.